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A SCIENCE ACTIVITY GUIDED BY CHILDREN AT PRE-SCHOOL LEVEL: FROM A STRING TO A PENDULUM

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Abstract. *A challenge was made to a pre-school class for an activity about science seeking to find situations where children use creativity in the process of science learning at this age level. No previous suggestion was given about the method and way of implementing the activity.*
The teacher prepared in advance a set of diverse materials that could be eventually used in due course of the activity. The teacher would guide the activity to arrive to the concept of pendulum, but the way to reach that would be defined by the children themselves.
The starting point was a simple string: to every child and the teacher was given a string of equal length. What could be done with such a string hanging in a hand was the first exercise. Immediately children´s imagination and creativity was shown.
After a while a simple pendulum was under observation and some functioning problems were detected and later on debugged by the children, whose suggestions led the teacher hanging the pendulum at a door's lintel.
In this communication, we will report and on the experiment enhancing the pedagogical and educational merit of this type of approach and to highlight some creative findings of five year old children thinking about a physical phenomena.

Keywords. Creativity, pre-school, science teaching

1. Aims and motivation

The learning of sciences is a major concern in order to raise children fully integrated in a technological society as we live in, improving their knowledge and skills in science and new technologies. The curiosity, imagination and creativity of children should be potentiated as early as possible, thus enabling them to feel comfortable and motivated when looking at and questioning natural phenomena, mathematical issues and modern technological devices.
This investigation was carried out in the context of a master thesis about creativity in the teaching/learning of sciences, from-pre-school to primary school, and we present the results obtained from a specific case among all the case studies.
Seeking to find children creativity in sciences at this level, a pre-school class was challenged to carry out an activity about science with no previous suggestion from the researchers about the theme, method and realisation of the activity. The challenge was accepted with enthusiasm.
The teacher´s proposal was to drive an activity to build and to use a pendulum, but the way to get there would be guided by the children´s inputs and suggestions. A set of diverse materials would be prepared in advance that could be eventually used in due course of the activity.

2. Instruments and methodology

Instruments

From a broader range of instruments used to record and to analyse the data collected, in this case we report only on the fieldnotes [1] and photographs [2] taken by the researchers and the interviews made to both the teacher [3] and some of the children [4] in the aftermath.

Methodology

The objective of the observation during this activity is to spot and to characterize at least three episodes of children creativity [5].
The notes taken include a time line [6] along which the observer records the development of the activity: the teacher's actions and speech, the children's interventions and comments, the actions taken and the events occurred. The latter processing of these field notes from different observers (actually 3), together with the pictures taken, enable to better identify and to characterize the quested creativity episodes.
The interviews include the observation by the teacher and the children of a sequence of pictures relative to one or more moments identified as

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having creativity. Among other aspects, this aftermath step allows the researchers to inquire about the strategies of the teacher to stimulate the learning process, the affection involvement of teacher and children with each other and the perceptions of the children on their interventions and their progress on the learning activity.

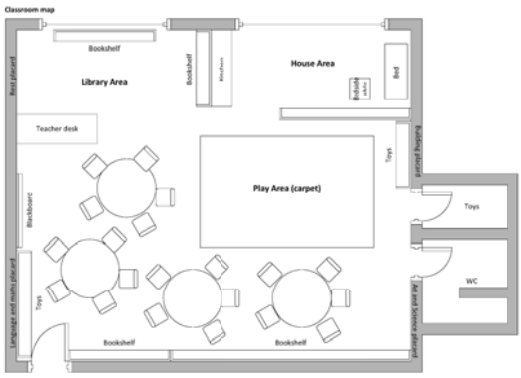

Figure 1. *Classroom plan*

3. Characterization of the class

The school, located in Braga, in northern Portugal, is a private educational catholic institution covering four levels of education: pre-school, primary school, 2nd and 3rd level of basic education; the students, in a total of 600, are aged between three to fifteen years old.
The class of this case has twenty two students (ten boys and twelve girls), with average age of 5 years old. There are no students with learning disabilities. The classroom is wide and bright with perfectly identified functional areas endowed with suitable materials (see Figure 1).

4. Activity and episodes

The aim of the activity is to build a pendulum (swing game) and study the factors that affect its motion (movement). Every child and the teacher had a string of equal length.
Children practice and develop the skills of systematic observation, questioning, planning and recording to obtain evidence, plan and execute an experiment whereby one variable is changed in order to obtain a certain result. Children work in a large group.
During the activity were identified three episodes of children creativity, which are presented next.

4.1. Episode 1 - Swing game - String

The teacher decided to perform an activity related to the pendulum and its movement. She began by questioning and dialoguing with the students about the length of the string and its effects in the pendulum motion, *"Which string should we use? A long one or a short one? If you want to make a swing (game), then you need a good swing. What is a good swing?"*
Regarding aspects of the lesson that involved creativity she states that from the moment she started the activity with only one string wagged by everyone and asking children what would happen or what could be done, they argued and showed that it was possible to have multiple movements and they have concluded that the movement could be tilting to one side and the other, with rhythm, and they also came to the conclusion that something should be hanging at the end of the string, making it similar to a clock room, like the one at their grandparents'.
And from there, students began the discovery of the simple pendulum. They explored a possibility with a string holding an espresso capsule at one end, and they gave the suggestion where the pendulum could be mounted. The first attempt was not successful because it was hanging from the wall (see Figure 2) and therefore the pendulum was bumping against the wall. The expected effect wasn't obtained and children suggested using the lintel of the door and then it was possible to realize exactly what was in their minds and what they expected to see (see Figure 3).

Figure 2. *Pendulum hanging from the wall*

Figure 3. *Pendulum hanging from the door lintel*

Science

At the beginning of the activity students weren't fully aware that the foothold of the string will affect its motion. They start the activity by

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exploring the string and making it to swing. After this short exploration phase, children are confronted with specific scientific problems concerning the swing game:

"If you want to make a swing game, then you need a good swing. What is a good swing? And what can be the rules for the game? How can you make such a game of your own?", the teacher asked.

While the children are building, they are engaged in an inquiry activity. They want to build a swing which meets the expectations of the game they have in mind. In order to integrate the results of the inquiry into the game, children need to have the chance to do the research themselves. Children make observations, they question and then they plan and execute experiments testing their hypothesis. Children discover some principles of pendulum motion by executing experiments with the swing game.

Creativity

Creativity is present in the resolution of the problem by the students and registered in like: *"My grandmother pendulum clock has a swing like the one we are looking for."*, which shows science process skills such as observing and describing the surrounding world. When the child was asked *"How can we build a swing like your grandmother has?"* she promptly answers: *"Attach the swing to the wall, hanging something at the end of the string.",* showing imagination and problem solving skills.

Suggesting a potential way to extend the activity or to provide a solution to the problem/question also shows creativity, students were able to build the proposed swing, and fix it to the wall. When trying to make it swing they observe that *"This isn't a swing! It hits the wall and doesn't swing.".* Many children tried to make it swing, unsuccessfully… so they reach a conclusion: *"The swing can't be fixed in the wall, because it's impossible to make it swing, hanging in there."* This part of the activity shows that students were able to questioning, gathering evidence, interpreting evidence and communicating findings.

After the first trial of building a swing a child suggested *"Maybe we can fix it to the top of the door opening."* So it was done, and the pendulum could swing at last.

4.2. Episode 2 - Swing game – Swing and hit

In this episode students discover some principles of swings by executing experiments with the swing game and develop the skills of systematic observation, questioning, planning and recording to obtain evidence.

Science

The teacher challenges: *"How can the pendulum tumble down these three plastic bottles?"*, Many children try to explain their ideas and put them in practice, mainly by trial and error. The teacher helps the children to test their hypothesis and to express their findings. She scaffolds the children to plan and execute an experiment whereby one variable is changed in order to obtain a certain result, *"Why are you putting the bottles closer?"; "What happens if the bottles are further away?"; "What happens if the string is small?".*

Children have to find a way to solve these research questions by using the materials at their disposal such as a universal holder, several objects of different shapes and weights. From now on they are engaged into real inquiry to solve the questions.

Creativity

Students realize that if they attach the pendulum to the tripod, it moves more freely and as more pendulum like movement. They soon find the need to use a heavy object (they use an orange inside a plastic bag) to hang from the string (see Figure 4).

Figure 4. *Final setup for tumbling down three bottles*

Child M: *"We have to use a long rope, and we have to put the bottles closer, so that we can drop them of more easily."*

The children build the swing. All elements come

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now together: the swing, the weight, the bottles, and the place of the bottles. The children are working on the swing and are driven by the teacher questions.
So before the game can be played, the children have to think about some options on how they will have to build the swing. They also need to take into account the different playing rules that were put forward earlier, c*hild G: "We have to bring the bottles closer to the pendulum.", child R: "We have to pull the pendulum more backwards."*.
While students are busy, the teacher can observe and engage the children into inquiry (designing and running experiments and observations). Children plan and conduct investigations in order to collect data.

4.3. Episode 3 - Swing game – Full Bottles

The situation that gave this episode was proposed by teacher at the end of the activity in order to challenge students and to realize if they understand the contents involved in all the activity: *"If one or two bottles are full of water how can you tumble them?"*

Science
This situation was proposed for evaluation, so children can demonstrate understanding of concepts and/or ability to use inquiry skills. They used data collected/observed in the previous activities, to construct knowledge and to generate evidence.
Child M pulls the string further backwards, adding to the bag containing two oranges, a tangerine but only one bottle (of two) tumbled.
Child S: "The tangerine has less weight; we have to add to the bag something more "heavy". We should use a wood block."
[Child S testing their hypothesis…]
Child S was succeeded: the bag with two oranges, a tangerine and a wood block, was able to tumble the two bottles full of water (see Figure 5).

Creativity
Creative disposition, such as imagination and connection making, is observed like when Child J says:"If we use more objects inside the bag, heavy objects, easier it is to tumble the bottles." Connection making is also observed when Child M states: "If we use a machine washer, all the bottles will also tumble."

5. Summary and conclusions

The teacher initiated the activity promoting the interest and curiosity of students, presenting problematic situations and discussing with them. During the activity the teacher was always careful to drive the children in their learning, encouraging their trial and error attempts to solve the problems.

Figure 5. *Two bottles down (only one is seen in the picture)*

The children were learning in a large group and suggestions were always given by them. All the children of the group were given the opportunity to express their thoughts and expectations prior to the experiments. All those who had suggestions were allowed to talk to everyone and everyone respected the time for others to talk. Each and every one had the opportunity to experience all the pendulums built, so there was a social dimension, social interaction and collaboration among children.
As the teacher referred in the interview it is very important to listen to the children, to pay attention to their opinions, their issues, their proposals, and work from those, as we had the opportunity to observe, to make a walk of teaching and learning along the way.
The teacher feels encouraged and motivated because when children are making experiments they are inherently motivated and their imagination and creativity are requested and successfully applied to solve problems. Furthermore, motivation and affective development are important aspects of the

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teacher's practice, as the play and learning are synonymous and children of this age do not distinguish between the two. This approach to play and exploration on children's interests allows them to follow their own lines of inquiry and create scientific understandings, alongside language development (including increasing vocabulary).

We would like to refer some items of this institution policy towards facilitating learning and development:

- planning activities that stimulate interest and curiosity in the children;
- providing support, scaffolding and allowing children to make their own learning decisions and solve problems in their own way;
- allowing the children to make decisions about the focus of their inquiry, even if that takes them away from the planned learning objectives;
- making connections between scientific concepts and phenomena, but not introducing scientific concepts artificially. Children are exploring their world and the teacher introduces new ideas or encourages further exploration when appropriate;
- reinforcing scientific concepts and vocabulary and thus supporting the development of the learning objectives.

It was a shot in the dark when we were complied to find evidences of creativity in teaching sciences at pre-school level. So we had to look for an institution and teachers who could eventually join our quest. Surprisingly, the findings, a few of which we report in this paper, have overcome our best expectations.

Quoting what the teacher of this class said in the interview: "*I learnt to respect the opinion of my students and realize that there is a lot of potential and it's them who have to do the story, making the way and if they do this construction, that's great!"*

6. Acknowledgements

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